CLAIMS

1. An information embedding modulator system for generating a composite signal from an embedded information signal and a host signal, comprising:

an analysis filter bank operating on the host signal, the analysis filter bank producing a plurality of analysis filter branch output signals;

an information embedder for embedding the embedded information signal into a selected analysis filter branch output signal;

a synthesis filter bank producing a plurality of synthesis filter branch output signals; and

a combiner for combining the synthesis filter branch output signals;

wherein the combiner yields a composite signal comprising information from both the host signal and the embedded information signal.

2. The system of claim 1, wherein the analysis filter bank comprises at least an analysis high-pass filter branch and an analysis low-pass filter branch.

3. The system of claim 1, wherein the synthesis filter bank comprises at least a synthesis high-pass filter branch and a synthesis low-pass filter branch.

4. The system of claim 1, wherein the analysis filter bank comprises a polyphase filter.

5. The system of claim 1, wherein the analysis filter bank comprises a decimated uniform discrete Fourier transform filter bank.

6. The system of claim 1, wherein the analysis filter bank comprises a block transformer.

7. The system of claim 6, wherein the block transformer is adapted for performing an extended lapped transform.

8. The system of claim 1, wherein the synthesis filter bank comprises a polyphase filter.

9. The system of claim 1, wherein the synthesis filter bank comprises a decimated uniform discrete Fourier transform filter bank.

10. The system of claim 1, wherein the synthesis filter bank comprises a block transformer.

11. The system of claim 10, wherein the block transformer is adapted for performing an inverse extended lapped transform.

12. The system of claim 1, wherein the information embedder comprises a non-intersecting embedding generator.

13. The system of claim 1, wherein the information embedder comprises a distortion-compensated QIM modulator.

14. The system of claim 1, wherein the information embedder comprises a non-compensated QIM modulator.

15. The system of claim 1, wherein the information embedder comprises a low-bit modulation embedder.

16. The system of claim 1, wherein the information embedder comprises a spread-spectrum modulation embedder.

17. The system of claim 1, wherein the combiner is included within the synthesis filter bank.

18. The system of claim 1, wherein the combiner comprises an adder.

19. The system of claim 1, further comprising a down-sampler at an output of an analysis filter branch.

20. The system of claim 1, further comprising an up-sampler at an input of a synthesis filter branch.

21. The system of claim 1, wherein the analysis filter bank and the synthesis filter bank form a perfect reconstruction filter set.

22. The system of claim 2, wherein the analysis high-pass filter and the analysis low-pass filter are orthogonal.

23. The system of claim 1, further comprising a broadcast signal receiver for generating the host signal.

24. The system of claim 23, wherein the broadcast signal is a television signal.

25. The system of claim 24, wherein the television signal is of any of the formats: PAL, PAL-M, PAL-N, SECAM, MESECAM, and NTSC.

26. The system of claim 1, further comprising a multiplexer for multiplexing the composite signal and a second signal.

27. The system of claim 1, further comprising an analog-to-digital converter at the input of the information embedding modulator.

28. The system of claim 1, further comprising a multiplexer at the output of the information embedding modulator for inserting a composite signal into a multiplexed signal.

29. The system of claim 1, further comprising a digital-to-analog converter for converting a digital composite signal into an analog composite signal.

30. The system of claim 1, wherein any of the filters, samplers, and information embedder are implemented using a digital signal processing technique.

31. The system of claim 1, wherein any of the filters, samplers, and information embedder are implemented using application specific integrated circuit hardware.

32. The system of claim 1, wherein any of the filters, samplers, and information embedder are implemented using field programmable gate arrays.

33. The system of claim 1, wherein any of the filters, samplers, and information embedder are implemented using a combination of hardware and software.

34. A method for modulating a host signal with an embedded information signal, comprising:

(a) passing the host signal through an analysis filter bank having a plurality of analysis filter branches;

(b) embedding the embedded information signal into a selected filter branch output signal of the analysis filter bank to produce a composite branch signal;

(c) passing the composite branch signal and outputs from other analysis filter bank output branch signals through a synthesis filter bank having a plurality of synthesis filter branches;

(d) combining outputs of the synthesis filter bank branches using a combiner to produce a composite signal.

35. The method of claim 34, wherein combining the outputs of the synthesis filter bank branches using a combiner comprises adding the outputs of the synthesis filter bank using an adder.

36. The method of claim 34, further comprising converting an analog host signal into a digital host signal using an analog-to-digital converter.

37. The method of claim 34 further comprising converting the composite signal to an analog composite signal using a digital-to-analog converter.

38. The method of claim 34, further comprising multiplexing the composite signal and a second signal, generating a multiplexed signal.

39. A method for modulating a host signal with an embedded information signal, comprising:

(a) splitting the host signal into a plurality of filtered branch signals using an analysis filter bank;

(b) decimating the filtered signals from (a) using down-samplers placed in at least one of the filtered branches;

(c) embedding an embedded information signal into at least one of the decimated filtered signals from (b) using an information embedder, producing at least one decimated branch composite signal;

(d) interpolating each of the signals from (b) and the decimated branch composite signals from (c) using up-samplers placed in each of the branches containing the signals from (b) and (c);

(e) filtering each of the interpolated signals from (d) using a synthesis filter bank corresponding to that signal;

(f) combining outputs of each branch in (e) to produce a composite signal comprising elements of both the host signal and the embedded information signal.

40. The method of claim 39, wherein the synthesis filter bank and the analysis filter bank form a perfect reconstruction filter set.

41. The method of claim 39, wherein combining outputs of each branch in (e) to produce a composite signal comprises adding outputs of each branch in (e) to produce a composite signal.

42. A method for embedding an embedded information signal into a host signal occupying a host signal channel, with reduced spillover of the embedded information signal into signal channels adjacent to the host signal channel, comprising:

splitting the host communication channel into a plurality of components using an analysis filter bank, the analysis filter bank having a plurality of output branches;

decimating the host signal component in at least one of the output branches to produce a decimated host signal;

embedding the information signal into the decimated host signal to produce a decimated composite signal containing the information signal and the decimated host signal.

43. The method of claim 42, further comprising oversampling and interpolating the decimated composite signal.

44. The method of claim 42, further comprising oversampling and interpolating the decimated host signal.

45. The method of claim 42, further comprising combining the decimated composite signal from at least one of the output branches to produce a combined composite signal containing host signal information and embedded signal information.

46. The method of claim 42, wherein the decimating and filtering are carried out by a decimating analysis filter bank.

47. The method of claim 42, wherein the oversampling and interpolating are carried out by an interpolating reconstruction filter bank.

48. The method of any of claims 42-43, wherein the filtering and interpolating satisfy a Nyquist criterion to produce substantially zero inter-symbol interference.

49. A cable head-end system adapted for embedding an embedded information signal into a host signal, comprising:

a broadcast signal receiver receiving at least one broadcast channel;

an information embedding modulator for generating a composite signal from the at least one broadcast channel and an embedded information signal, the modulator comprising:

an analysis filter bank operating on the host signal, the analysis filter bank having at least an analysis high-pass filter branch and an analysis low-pass filter branch;

an information embedder for embedding the embedded information signal into a selected analysis filter branch output;

a synthesis filter bank, having at least a synthesis high-pass filter branch and a synthesis low-pass filter branch; and

an adder for adding outputs of the synthesis filter branches, the adder yielding a composite signal containing information from both the host signal and the embedded information signal;

and a transmitter for transmitting the composite signal to a user.

50. The system of claim 49, further comprising a down-converter for converting a first frequency to a second lower frequency.

51. The system of claim 49, further comprising an up-converter for converting a first frequency to a second higher frequency.

52. The system of claim 49, further comprising an analog-to-digital converter upstream of the information embedding modulator.

53. The system of claim 49, further comprising a digital-to-analog converter downstream of the information embedding modulator.

54. An information embedding modulator system for embedding an embedded information signal into a host signal, comprising:

an analysis filter bank operating on the host signal, the analysis filter bank having an analysis filter branch with a corresponding analysis filter branch output;

an information embedder for embedding the embedded information signal into the analysis filter branch output;

a first combiner for subtracting the analysis filter branch output from an output of the information embedder;

a synthesis filter bank, having an input from the output of the first combiner; and a second combiner for combining an output of the synthesis filter bank and the host signal, the second combiner yielding a composite signal containing information from both the host signal and the embedded information signal.

55. The system of claim 54, wherein the first combiner comprises an adder.

56. The system of claim 54, wherein the first combiner comprises an inverter.

57. The system of claim 54, further comprising an inverter at an input of the first combiner.

58. The system of claim 54, wherein the second combiner is included within the synthesis filter bank.

59. The system of claim 54, further comprising a down-sampler at the output of the analysis filter branch.

60. The system of claim 54, further comprising an up-sampler at the input of the synthesis filter branch.

61. The system of claim 54, wherein the analysis filter bank and the synthesis filter bank form a perfect reconstruction filter set.

62. The system of claim 54, further comprising a broadcast signal receiver for generating the host signal.

63. The system of claim 62, wherein the broadcast signal is a television signal.

64. The system of claim 63, wherein the television signal is of any of the formats PAL, PAL-M, PAL-N, SECAM, MESECAM, and NTSC.

65. The system of claim 54, further comprising an analog-to-digital converter placed at an input of the information embedding modulator system.

66. The system of claim 54, further comprising a multiplexer at an output of the information embedding modulator system for inserting a composite signal into a multiplexed signal.

67. The system of claim 54, further comprising a digital-to-analog converter placed at an output of the information embedding modulator system.

68. The system of claim 54, wherein any of the filters, samplers, and information embedder are implemented using a digital signal processor.

69. The system of claim 54, wherein any of the filters, samplers, and information embedder are implemented using application specific integrated circuit hardware.

70. The system of claim 54, wherein any of the filters, samplers, and information embedder are implemented using field programmable gate arrays.

71. The system of claim 54, wherein any of the filters, samplers, and information embedder are implemented using a combination of hardware and software.

72. The system of claim 54, wherein the analysis filter bank comprises at least an analysis high-pass filter branch and an analysis low-pass filter branch.

73. The system of claim 54, wherein the synthesis filter bank comprises at least a synthesis high-pass filter branch and a synthesis low-pass filter branch.

74. The system of claim 54, wherein the analysis filter bank comprises a polyphase filter.

75. The system of claim 54, wherein the analysis filter bank comprises a block transformer.

76. The system of claim 75, wherein the block transformer comprises an extended lapped transformer.

77. The system of claim 54, wherein the synthesis filter bank comprises a polyphase filter.

78. The system of claim 54, wherein the synthesis filter bank comprises a block transformer.

79. The system of claim 78, wherein the block transformer comprises an inverse extended lapped transformer.

80. The system of claim 54, wherein the information embedder comprises a non-intersecting embedding generator.

81. The system of claim 54, wherein the information embedder comprises a distortion-compensated QIM modulator.

82. The system of claim 54, wherein the information embedder comprises a non-compensated QIM modulator.

83. The system of claim 54, wherein the information embedder comprises a low-bit modulation embedder.

84. The system of claim 54, wherein the information embedder comprises a spread-spectrum modulation embedder.

85. A method for embedding an embedded information signal into a host signal occupying a host signal channel, with reduced spillover of the embedded information signal into signal channels adjacent to the host signal channel, comprising:

splitting the host communication channel into a plurality of components using an analysis filter bank, said analysis filter bank having an analysis filter branch component;

decimating the host signal component in the analysis filter branch component to produce a decimated filtered host signal; and

embedding the information signal into the decimated filtered host signal to produce a decimated filtered composite signal comprising the embedded information signal and the decimated filtered host signal.

86. The method of claim 85, further comprising subtracting the decimated filtered host signal from the decimated filtered composite signal.

87. The method of claim 85, further comprising oversampling and interpolating the decimated filtered composite signal.

88. The method of claim 85, further comprising combining the decimated filtered composite signal and the host signal to produce a composite signal containing host signal information and embedded signal information.

89. The method of claim 85, wherein the decimating and filtering are carried out in a decimating analysis filter bank.

90. The method of claim 85, wherein the oversampling and interpolating are carried out in a synthesis filter bank.

91. The method of claim 90, wherein the analysis and the synthesis form a perfect reconstruction operation.

92. The method of claim 86, wherein the decimation and interpolation satisfy a Nyquist criterion to produce substantially zero inter-symbol interference.

93. An information extracting demodulator system for extracting embedded information from a composite signal, comprising:

an analysis filter bank, operating on the composite signal, the analysis filter bank having an analysis filter output; and

an information extractor for extracting embedded information from the analysis filter output.

94. The system of claim 93, wherein the analysis filter bank comprises at least an analysis high-pass filter branch and an analysis low-pass filter branch.

95. The system of claim 93, wherein the analysis filter bank comprises a polyphase filter.

96. The system of claim 93, wherein the analysis filter bank comprises a block transformer.

97. The system of claim 96, wherein the block transformer comprises an extended lapped transformer.

98. The system of claim 93, further comprising a demultiplexer for demultiplexing the composite signal and a second signal.

99. The system of claim 93, further comprising a down-sampler at an output of an analysis filter branch.

100. The system of claim 93, further comprising a receiver for receiving the composite signal.

101. The system of claim 93, wherein the composite signal comprises an embedded information and a host signal information.

102. The system of claim 101, wherein the host signal is a television signal.

103. The system of claim 102, wherein the television signal is of any of the formats: PAL, PAL-M, PAL-N, SECAM, MESECAM, and NTSC.

104. The system of claim 93, further comprising an analog-to-digital converter for converting an analog composite signal to a digital composite signal.

105. The system of claim 93, wherein any of the filters, samplers, and information extractor are implemented using a digital signal processing technique.

106. The system of claim 93, wherein any of the filters, samplers, and information extractor are implemented using application specific integrated circuit hardware.

107. The system of claim 93, wherein any of the filters, samplers, and information extractor are implemented using field programmable gate arrays.

108. The system of claim 93, wherein any of the filters, samplers, and information extractor are implemented using a combination of hardware and software.

109. A method for demodulating a composite signal, comprising:

(a) filtering the composite signal using an analysis filter bank;

(b) extracting embedded information from the composite signal to yield extracted information corresponding to the embedded information.

110. The method of claim 109, further comprising demultiplexing a multiplexed signal to obtain the composite signal therefrom.

111. A communication system, for delivering information from a head end to a user end, comprising:

an information embedding modulator for embedding embedded information into a host signal, the modulator comprising a modulator analysis filter bank, an information embedder, a synthesis filter bank, and a combiner for providing a composite signal containing information from both the host signal and the embedded information signal, and

an information extracting demodulator, the demodulator comprising a demodulator analysis filter bank receiving and filtering the composite signal, and an information extractor for extracting the embedded information.

112. The system of claim 111, wherein the modulator analysis filter and the demodulator analysis filter have substantially similar transfer functions.

113. The system of claim 111, wherein any of the filters is implemented as polyphase filters.

114. The system of claim 111, wherein any of the filters is implemented as a block transform.

115. The system of claim 114, wherein the block transform comprises an extended lapped transform.

116. The system of claim 111, further comprising a broadcast signal receiver for receiving a broadcast signal.

117. The system of claim 111, further comprising a multiplexer for multiplexing a plurality of communication channels, at least one of which serves as a host channel.

118. A method for communicating between a cable head end and a user end with reduced spillover of an embedded information signal into signal channels adjacent to a host signal channel, comprising:

embedding the embedded information signal into at least a portion of the host signal using an information embedder, wherein the portion of the host signal has a bandwidth smaller than the bandwidth of the host signal channel;

modulating the host signal with the embedded information signal using an information embedding modulator, producing a composite signal comprising information from both the host signal and the embedded information signal;

transmitting the composite signal over a communication channel to the user end;

receiving the composite signal at the user end; and

demodulating the composite signal using an information extraction demodulator adapted for extracting the embedded information signal from the composite signal.

119. The method of claim 118, further comprising extracting an extracted information signal, corresponding to the embedded information signal, from the composite signal.